Name: Rapid Creek Watershed County: Pennington and Lawrence

Fish populations in Rapid Creek, Castle Creek, and Cement Plant Creek within the Rapid Creek watershed (Figure 1) were surveyed during 2007 to monitor populations and investigate impacts of drought and *Didymosphenia geminate*, an invasive diatom alga currently found within Rapid Creek.

The majority of Rapid Creek and its tributaries are managed under standard regulations with a daily limit of five trout (in any combination) with one allowed 14 inches or longer. Two sections of Rapid Creek are managed under catch and release regulations where the harvest of fish and possession of organic bait within 100 feet of the stream are prohibited. The Pactola Basin area (from Pactola Dam downstream 2 miles to the Placerville foot bridge) has been managed under catch-and-release regulations since 1991. Rapid Creek within Rapid City adjacent to Meadowbrook Golf Course (from Park Drive to Jackson Boulevard) has been managed under catch-and-release regulations since 2006.

Methods

Ten 100 m reaches in Rapid Creek (Figure 2), two 100 m reaches in Castle Creek (Figure 3), and one 100 m reach in Cement Plant Pond (Figure 4) were surveyed during September and October under base flow conditions and prior to the fall spawning of brown and brook trout. Conclusions about the status of fish populations based on these samplings are tenuous at best due to the relatively small number of sample sites. However, this is the only data available from this year and conclusions must be made from the data. It is important to remember estimates from these samples include a relatively high degree of variance and do not represent an unbiased estimate of populations (Johnson et al. 2007).

Despite the lack of statistical rigor, efforts were made to ensure the required assumptions 1) the population is static and 2) number of fish was recorded properly were met. Block nets at the upstream and downstream boundaries were used to prevent fish from emigrating or immigrating within the sample site. Three passes were made with one or two backpack electrofishing units. Captured fish were anesthetized with carbon dioxide, measured to the nearest millimeter, weighed to the nearest gram and returned to the stream. After 50 individual lengths and weights were collected from small fish (< 100mm) of a specific species, bulk counts were then collected to expedite data collection. A three-pass depletion estimate was used to estimate the number of fish within the sample reach (Guy and Brown 2007). Estimated numbers of fish within reaches were averaged to yield an estimate of number of fish per 100 m throughout the creek.

In addition to fish data, pH, temperature, and specific conductance were measured and recorded. Additionally, stream widths were measured every 10 m and averaged to obtain an estimate of total area sampled.

Rapid Creek stream flow data was downloaded from the USGS web site (available at: http://waterdata.usgs.gov/sd/nwis) for water years 1996-2006. Historical flow data for water year 2007 is not currently available. Population estimates in Rapid Creek were plotted against flow data to look for possible effects of discharge on fish populations.

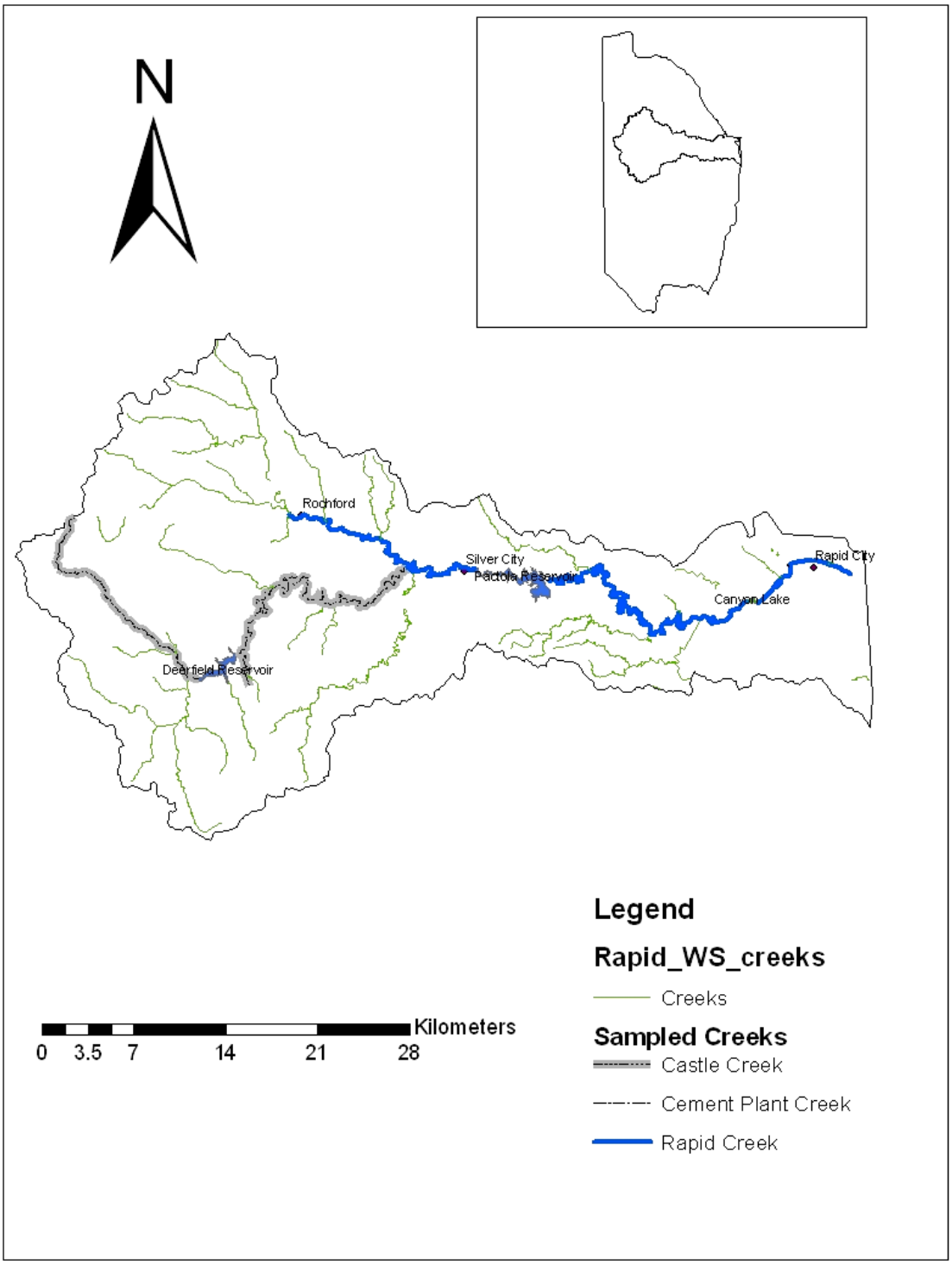

Figure 1. Rapid Creek Watershed within the Black Hills Trout Management Area with creeks sampled in 2007 highlighted.

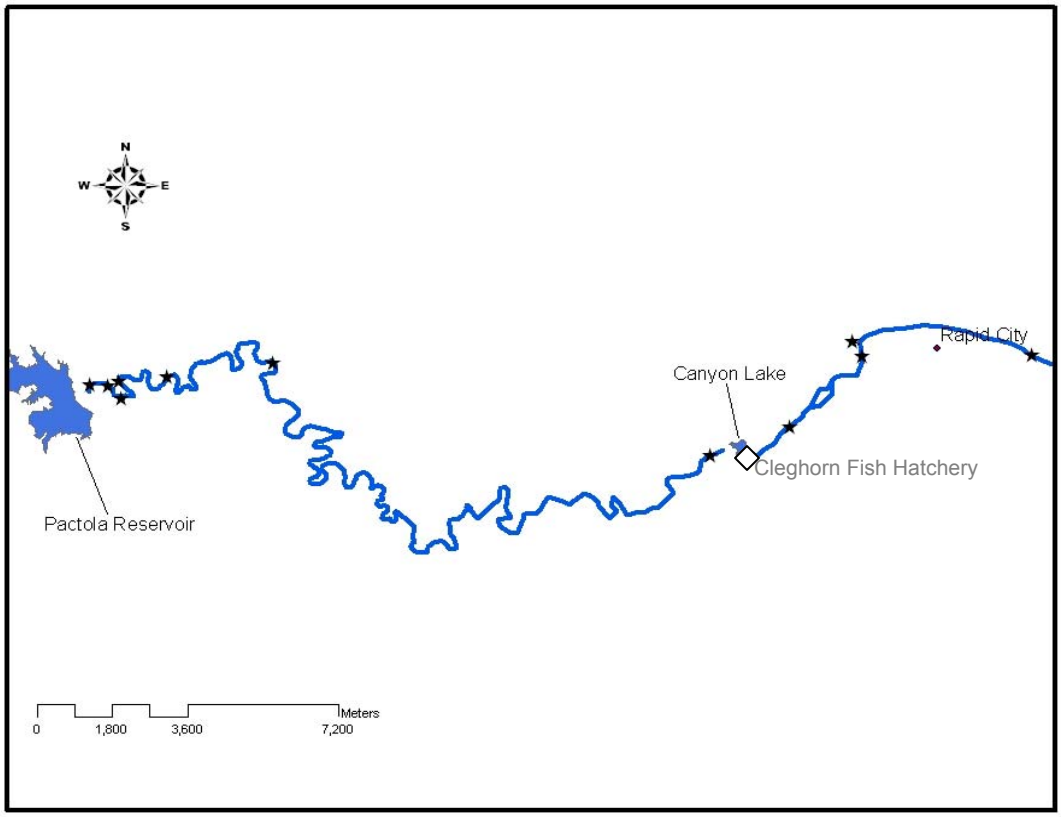

Figure 2. Map of Rapid Creek with 2007 sample sites denoted by a star.

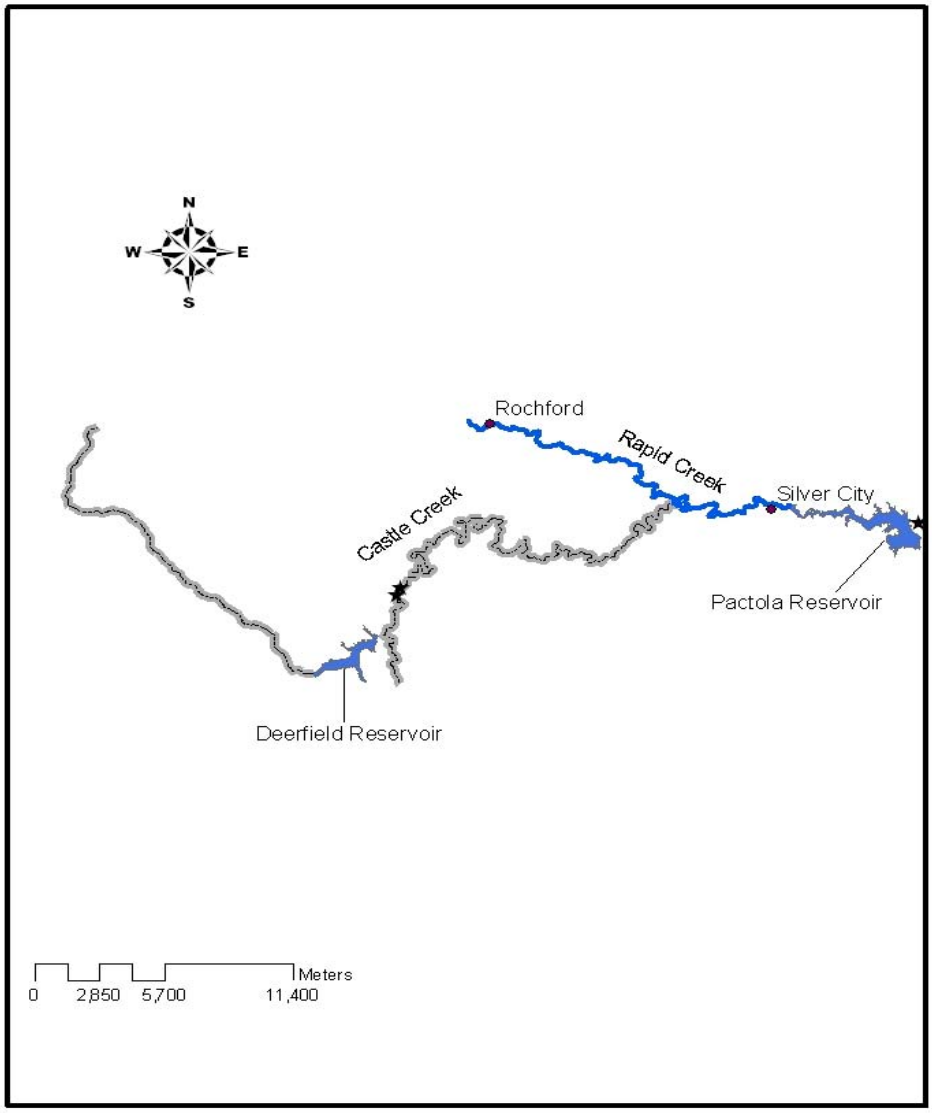

Figure 3. Map of Castle Creek with sample sites denoted by a star.

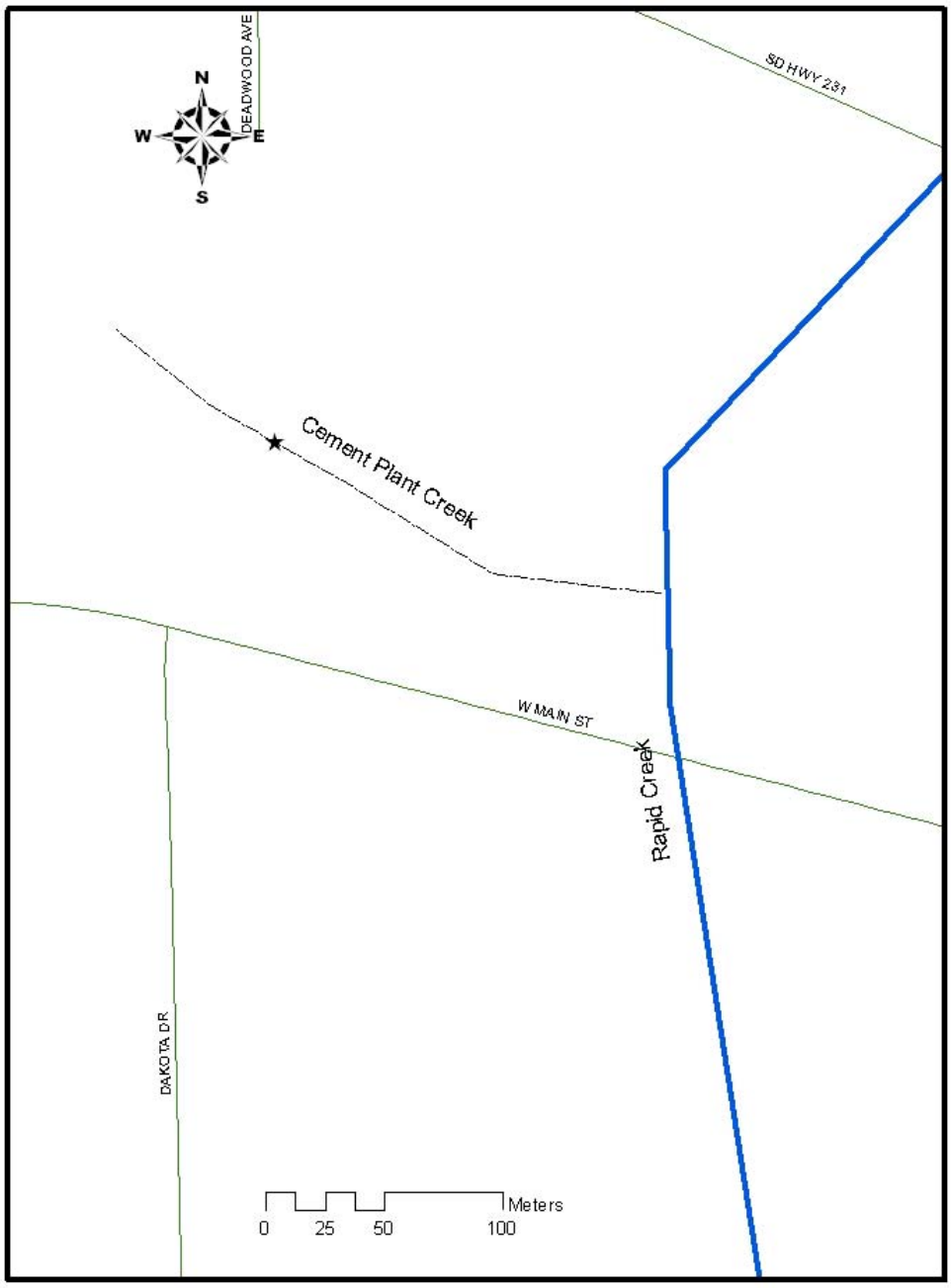

Figure 4. Map of Cement Plant Creek within Rapid City, SD with sample site denoted by a star.

Results and Discussion

Rapid Creek

Ten species of fish were captured in Rapid Creek during sampling (Table 1). Salmonids dominated the fish community, especially in the upper reaches near Pactola basin where they were the only species present. Brown trout were sampled in all ten of the sample reaches. Brook trout were only sampled in the sites immediately downstream from Pactola stilling basin. Rainbow trout were sampled in all reaches above Canyon Lake, but only one was sampled in the reaches downstream from Canyon Lake. Longnose dace and white sucker first appear at the sampling site just upstream from Cleghorn Springs Fish Hatchery and were present in all sampling sites downstream from Canyon Lake. Rock bass were sampled in all reaches below Canyon Lake and appeared to increase in abundance with downstream progression. Numbers of rock bass captured ranged from two fish in the upper reach to 30 in the lower most sample reach. Green sunfish, largemouth bass, northern pike, and creek chub were also sampled below Canyon Lake, but occurred in low abundances.

Table 1. List of fish species captured during 2007 sampling in Rapid Creek within the Rapid Creek watershed.

Common name	Scientific name
Brown trout	*Salmo trutta*
Rainbow trout	*Oncorhynchus mykiss*
Brook trout	*Salvelinus fontinalis*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Northern pike	*Esox lucius*
Rock bass	*Ambloplites rupestris*
Creek chub	*Semotilus atromaculatus*
Longnose dace	*Rhinichthys cataractae*
White sucker	*Catostomus commersoni*

The remainder of this report will focus on salmonids as they were the focus of the population investigation. While noting the occurrence of the other species is important, they do not presently occur in high enough abundance to justify further discussion of their populations.

Brown Trout – Rapid Creek appeared to have a relatively large population of juvenile (<200 mm) brown trout (Table 2) indicating spawning success in the fall of 2006. However, the number of adult fish was much smaller resulting in Rapid Creek being classified as a class II (25-150 fish per acre) brown trout fishery.

Table 2. Population estimates in number of fish per 100 m of stream and number of fish per surface acre of water for Rapid Creek in the Rapid Creek watershed.

Species	Size	Number/100 m	Number/ac
Brown Trout	< 200 mm	317.8	1388.9
Brown Trout	≥ 200 mm	10.4	61.9
Rainbow Trout**	< 200 mm	31.4	166.7
Rainbow Trout**	≥ 200 mm	5.6	32.9
Brook Trout*	< 200 mm	25	92.5
Brook Trout*	≥ 200 mm	1.25	4

*- denotes estimates using only sample sites within Pactola Basin
**- denotes estimates using only sample sites upstream of Canyon Lake

Streams are dynamic systems making it difficult to pinpoint factors associated with the divergence in the numbers of juvenile and adult brown trout within Rapid Creek. While there are likely many factors contributing to the decline in adult fish and the proliferation of juvenile fish, two reasons are commonly given for this divergence. One is the presence of *Didymosphenia geminate* (Didymo) within Rapid Creek, and the other is the prolonged drought the area has been experiencing.

Didymo was first reported in Rapid Creek in 2002, and is now known to occur from Pactola Basin downstream to Dark Canyon. It is believed that didymo alters the invertebrate communities on which trout feed resulting in deleterious effects on adult trout populations (Hayes et al. 2006). For more detailed information about effects of didymo see Kilroy et al. (2005) and Hayes et al. (2006). While adult brown trout numbers have declined since the discovery of didymo, closer examinations of population trends indicated numbers of adult brown trout declined substantially starting in 2000, two years before the discovery of didymo (Figure 5). It is unlikely nuisance blooms of didymo occurred and were not reported prior to 2002 since the Rapid Creek experiences a fair amount of angling pressure (Simpson 2007) and the presence of homes along much of the creek. Therefore, didymo may have some negative effect on the adult brown trout population, but is likely not the major factor responsible for the decline.

While adult brown trout numbers have been declining, the numbers of juvenile brown trout have increased exponentially (Figure 5). It appeared that the numbers began increasing in 2004, which was two years after didymo was discovered. However, this is likely due to release from intraspecific predation and competition with adult fish and not due to the appearance of didymo. The observed high abundance of juvenile fish indicated that the low number of adults is not a result of spawning failure. Numbers of juvenile brown trout over the past three years are two to three times of what was observed over the last ten years. Therefore, reduced numbers of adult brown trout are due to lack of recruitment into the fishery. Length frequency histogram analysis indicated the number of fish began a steady decline after they reached a length of about 150 mm (Figure 6). A three year study is currently underway investigating the effects of didymo on the recruitment of adult fish. Results of this study will not be available until 2011.

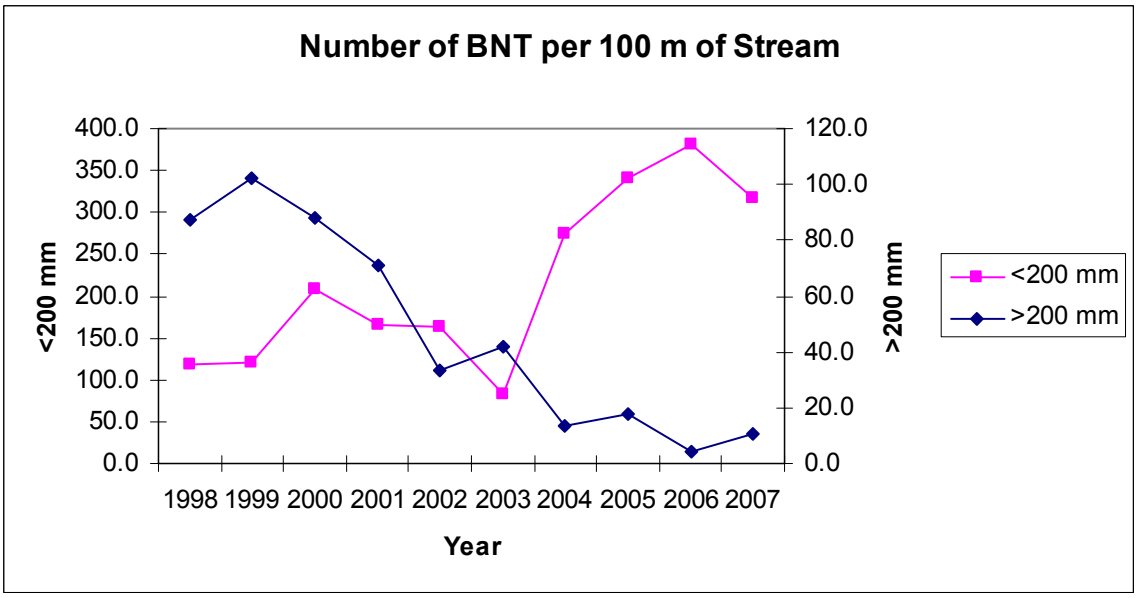

Figure 5. Estimated number of adult (>200 mm) and juvenile (<200 mm) brown trout (BNT) per 100 m of stream within Rapid Creek in the Rapid Creek watershed.

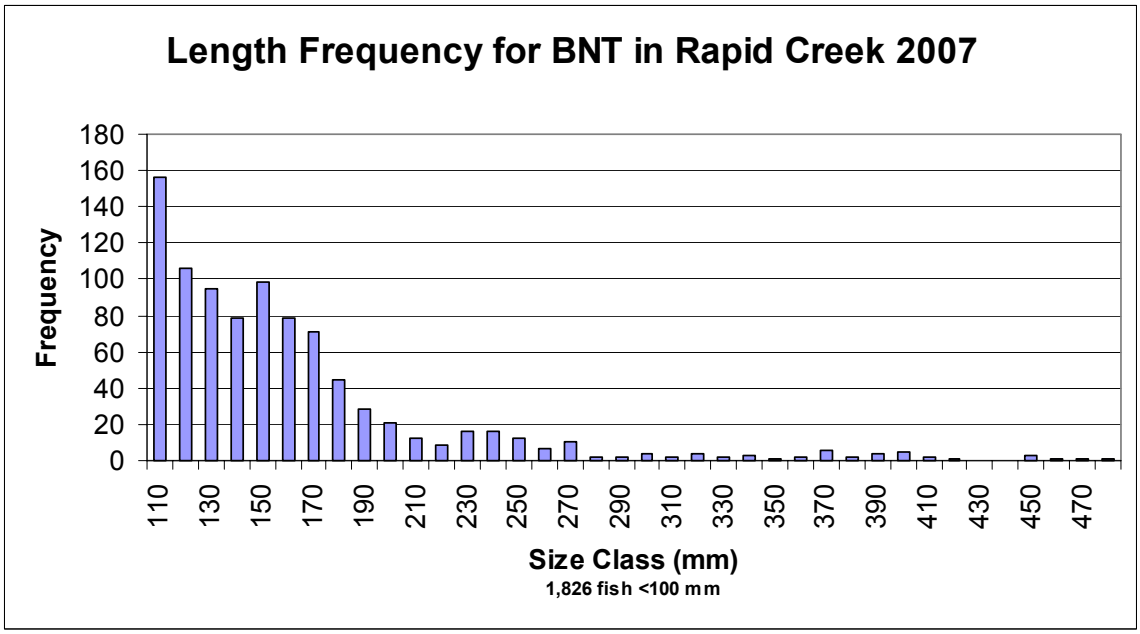

Figure 6. Length frequency histogram for brown trout (BNT) sampled from Rapid Creek in 2007.

A more likely culprit in the decline of brown trout is the persistent drought experienced over the last eight years in the Black Hills. When number of adult brown trout per 100 m of stream is plotted against mean monthly winter discharge (October – March) a relationship becomes apparent (Figure 7). October – March monthly flows were chosen because these months typically reflect the base flows within Rapid Creek. As the drought persisted, winter flow decreased each year as did the numbers of adult brown trout. The relationship becomes more apparent when the previous years winter discharge is plotted

against the number of adult brown trout per 100 m of stream (Figure 8). This relationship indicates that base flow conditions and thus the effects of prolonged drought is the major factor affecting adult brown trout numbers. This scenario is likely playing out in many Black Hills streams.

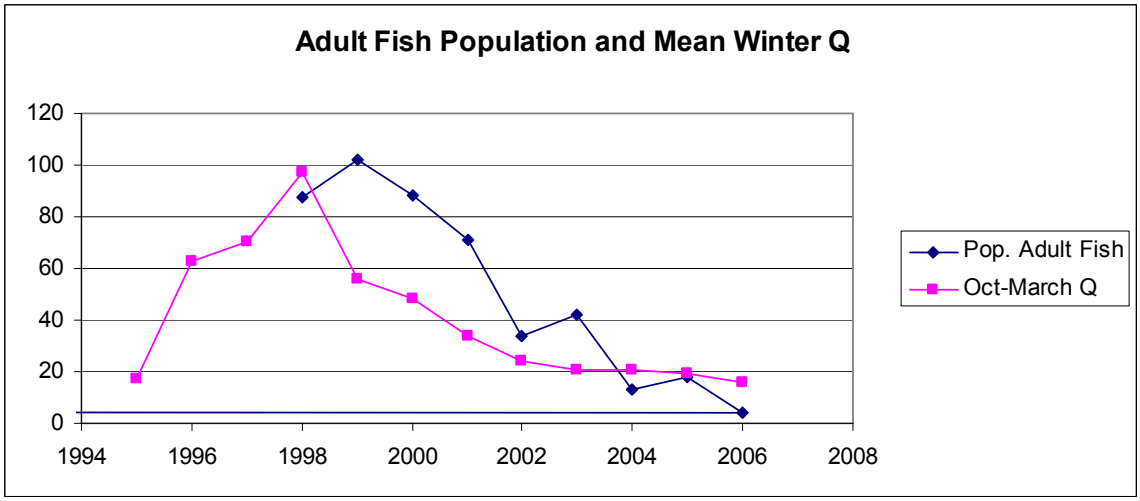

Figure 7. Number of adult brown trout per 100 m of stream plotted with mean monthly winter (Oct-March) discharge within Rapid Creek in the Rapid Creek watershed.

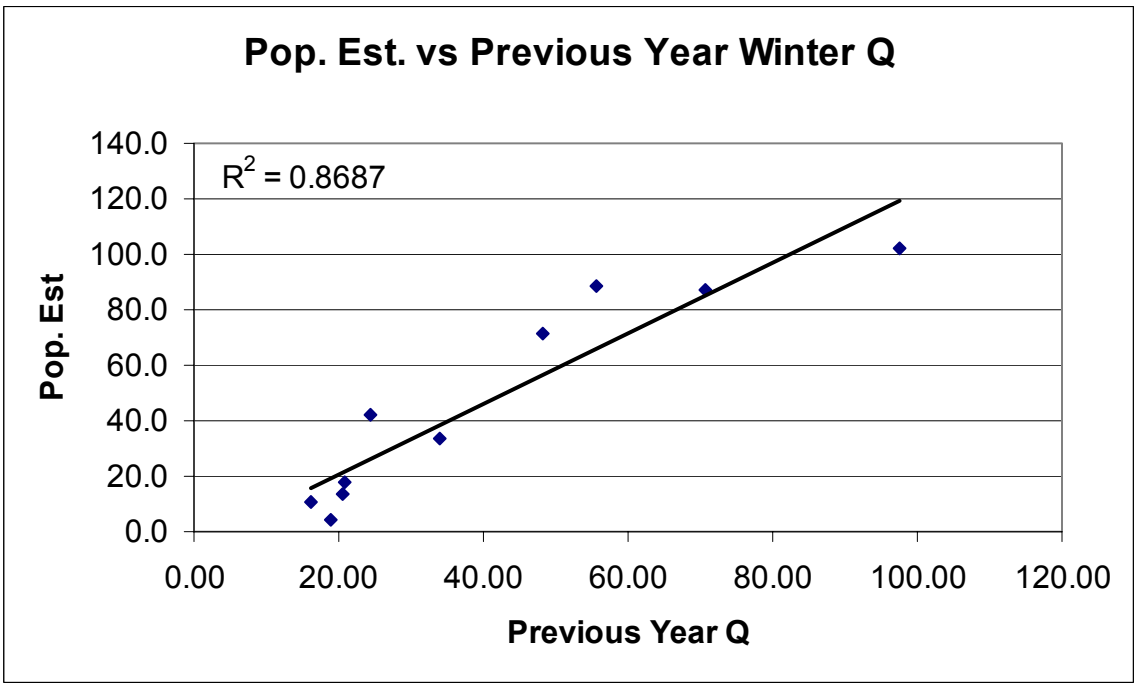

Figure 8. Number of adult brown trout per 100 m of stream plotted against previous years winter discharge within Rapid Creek in the Rapid Creek watershed.

Rainbow Trout – Rainbow trout were sampled in eight of the ten sample reaches within Rapid Creek. However, they occurred in much lower abundances (Table 2). Rainbow

trout appear to be uncommon in Rapid Creek below Canyon Lake as only one was captured within the three downstream reaches. However, numbers of rainbow trout above Canyon Lake are high enough to be classified as a Class I rainbow trout fishery (≥ 25 adult fish per acre), but these fish are most likely stocked fish and therefore do not count toward classification status of the stream.

Numbers of rainbow trout in Rapid Creek are probably dependent on supplemental stocking by South Dakota Game, Fish, and Parks. In 2007, approximately 1,307 rainbow trout were stocked in the section of Rapid Creek between Pactola Basin and Canyon Lake. This averages out to about 3.6 trout stocked per 100 m of stream. Number of rainbow trout stocked per 100 m of stream is statistically the same as the estimated number of rainbow trout from stream sampling.

The presence of juveniles does indicate that reproduction is occurring to some extent since only catchable adult trout (≥ 11") are stocked within Rapid Creek. However, not enough of the naturally reproduced fish appear to be recruiting into the fishery to support rainbow trout within Rapid Creek. The number of juvenile fish is low especially when compared to the number of juvenile brown trout within Rapid Creek. This coupled with the prolonged drought has likely resulted in the inability of Rapid Creek to support a wild rainbow trout population.

The population of rainbow trout within Rapid Creek has varied over the past 10 years (Figure 9). Yet, it is difficult to draw many conclusions from the trends since rainbow trout occur in relatively low densities. Also, number of sample sites has varied from year to year resulting in relatively high variance in the population estimates. The number of rainbow trout stocked in a year probably has the greatest effect on the population of rainbow trout in Rapid Creek.

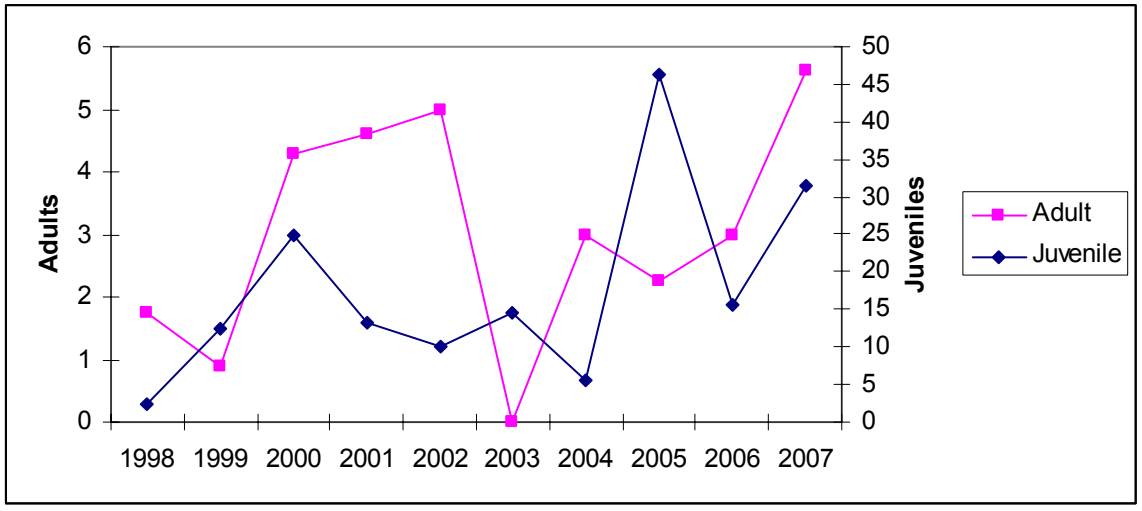

Figure 9. Estimated number of adult (≥ 200 mm) and juvenile (<200 mm) rainbow trout within Rapid Creek in the Rapid Creek watershed.

One final interesting observation is the fact that even though trout have been stocked in Rapid Creek, the population does not appear to grow from year to year. One possible explanation is that the fish are removed by anglers. This is unlikely since creel surveys indicate that very few fish are removed from Rapid Creek by anglers (Simpson 2007). It appears more likely that fish stocked the previous year experience a high degree of natural mortality and do not survive much more than a year. Further investigation is required to verify if this is true. If this is the case, it may be necessary for South Dakota Game, Fish and Parks to revise its rainbow trout stocking strategy in Rapid Creek.

Brook trout – Brook trout were sampled in the three most upstream sample sites. The highest densities of brook trout were in the most upstream site directly downstream from the Pactola stilling basin, and number declined with downstream progression. The number of brook trout per 100 m of stream is relatively low through these sites (Table 2) resulting in this section of Rapid Creek being classified as a Class III brook trout fishery (< 25 adult fish per acre). Brook trout may occur in these reaches of Rapid Creek due to their proximity to the stilling basin.

Castle Creek

Two sites (Figure 3) were sampled within Castle Creek, and the sites were within a half mile of one another. The sites proximity to one another and the small sample size resulted in a sample design not statistically robust enough to make valid inferences about the entire Castle Creek stream system (Johnson et al. 2007). Therefore, discussion on Castle Creek will be based exclusively on the mean population estimates from the two sample sites.

Castle Creek is located in the upper sections of Rapid Creek Watershed (Figure 1). Thus, it would be expected that only salmondis would likely be present in these reaches of stream. Species captured (brown and brook trout) were the same as what has historically been sampled within the two sites in Castle Creek (South Dakota Game, Fish, and Parks Cold Stream Database). Some interesting observations were made in the abundances of juvenile and adult brown and brook trout. Juvenile brook trout (<200 mm) were more abundant than juvenile brown trout (Table 3). However, the opposite is true for adult fish with adult brown trout being more abundant.

Table 3. Estimated mean number per 100 m of stream and number per acre of juvenile and adult brown and brook trout from two sample sites on Castle Creek.

Species	Size	Number/ 100 m	Number/ ac
Brown trout	<200 mm	38	309.5
Brown trout	≥200 mm	12.5	97
Brook trout	<200 mm	76.5	628
Brook trout	≥200 mm	1.5	11.5

Brown trout – Population estimates of brown trout resulted in this section of Rapid Creek being classified as a class II brown trout fishery. Trends in brown trout abundance are similar to that of Rapid Creek (Figure 5) with a decline in numbers of adult fish (Figure 10). Abundances of adult fish within these two sites are about one half of what they were in 2003. Abundance of juvenile fish appears to be quite variable with a peak in 2004 and a sharp decline in 2007. This is in contrast to the substantial increase of juveniles noted within Rapid Creek. However, this may just be a result of the small sample size not able to capture variation throughout the system. More sampling effort may have revealed a trend similar to that observed in Rapid Creek. The decline in adult brown trout in Castle Creek is likely related to the prolonged drought.

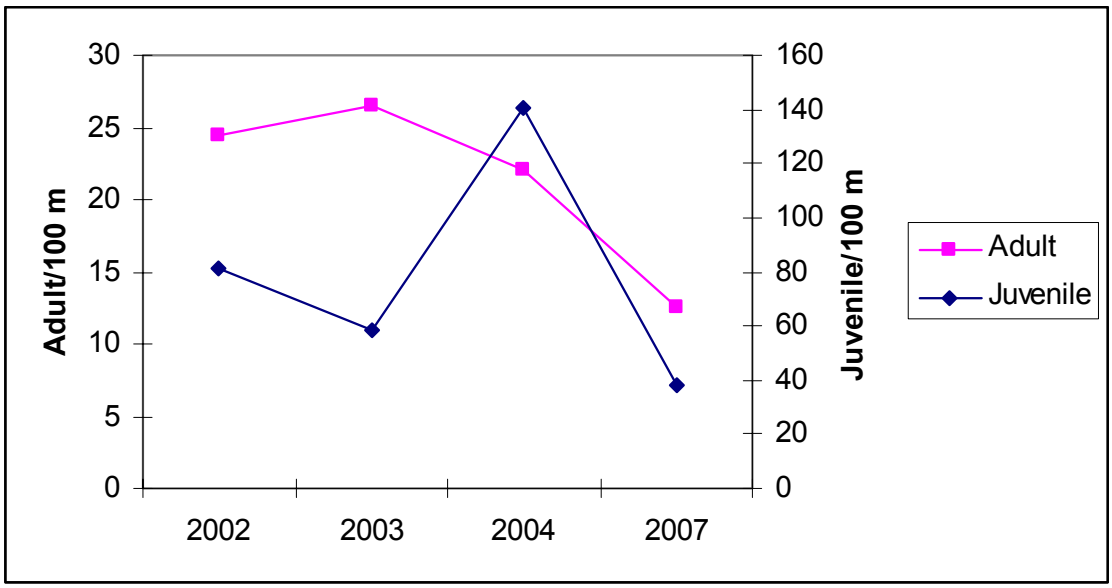

Figure 10. Trends in mean estimated number of adult and juvenile brown trout in sites 16 and 17 within Castle Creek.

Examination of a length frequency histogram indicated the presence of multiple year classes (Figure 11). Also, the second peak in the bimodal distribution occurs at about 190 mm. This would indicate that fish recruit into the adult population at around two years of age. Another interesting observation in the length frequency histogram is that age two fish appear to be almost as abundant as age one. This observation could be cause for encouragement as it indicates a relatively strong year class being recruited into the adult fishery resulting in a surge in the numbers of adult fish in the next few years. This assessment is highly speculative however once again due to the small sample size.

Brook trout – Numbers of adult brook trout within Castle Creek were relatively low indicating a class III brook trout fishery. Trends in abundances of adult brook trout are similar to that of brown trout (Figure 12), but adult brook trout occurred in relatively low abundances in all years they were sampled. One interesting note is the number of juvenile brook trout increasing and in 2007 occurred in higher abundances than juvenile brown trout.

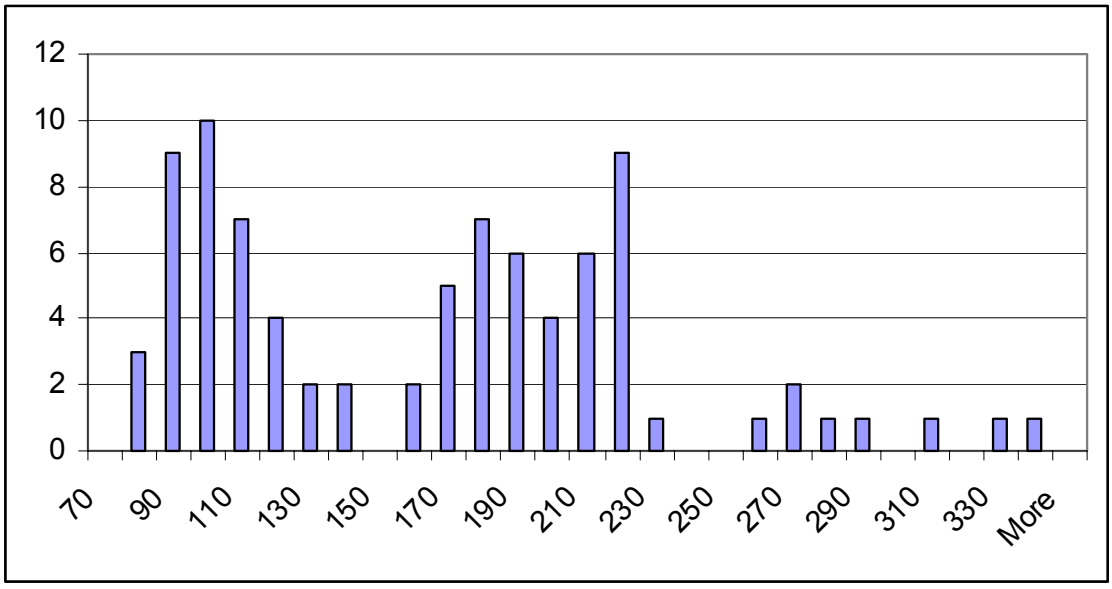

Figure 11. Length frequency histogram for brown trout captured in Castle Creek sites 16 and 17 during stream sampling.

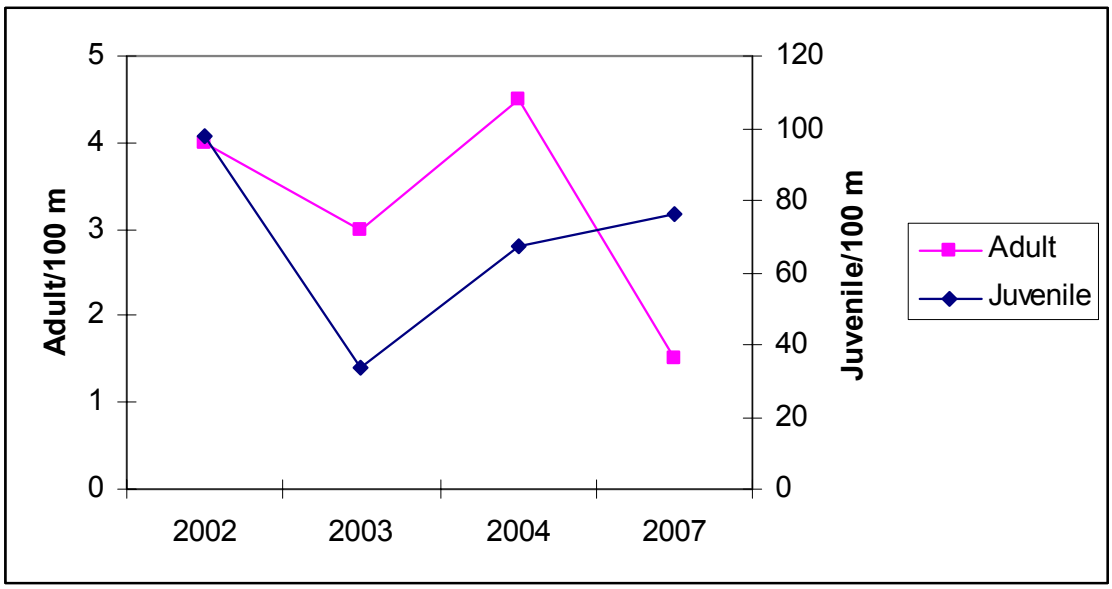

Figure 12. Trends in mean estimated number of adult and juvenile brook trout in sites 16 and 17 within Castle Creek.

Examination of a length frequency histogram for brook trout further demonstrated the higher abundance of juvenile brook trout (Figure 13). Also, it is important to note the apparent lack of brook trout older than age two. It may be that this area is important nursery habitat for young brook trout, and once they reach about 190 mm they emigrate

to other areas. However, to be certain more intensive sampling over a larger spatial area needs to occur.

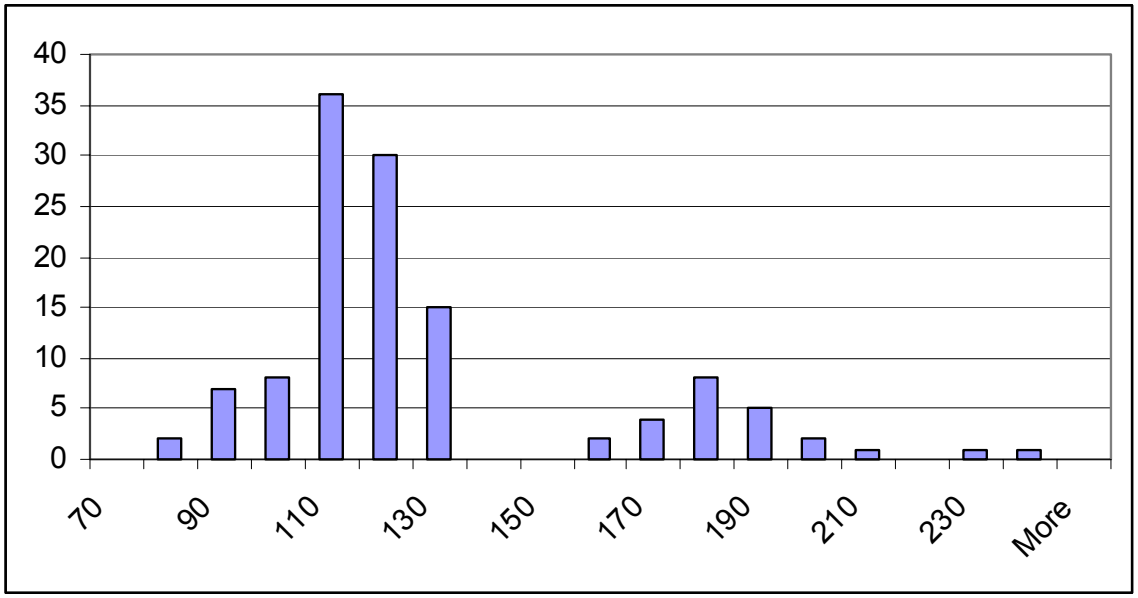

Figure 13. Length frequency histogram for brook trout captured in Castle Creek sites 16 and 17 during stream sampling.

Cement Plant Creek

Cement Plant Creek was sampled to investigate its function within the Rapid Creek fishery, and to determine if it warrants a reclassification by South Dakota Department of Environment and Natural Resources to a coldwater marginal fishery. Cement Plant Creek is a small tributary stream entering Rapid Creek within Rapid City, SD. Only one site was sampled on Cement Plant Creek, but this site included the entire creek that is accessible. The upstream boundary of the sample site is a culvert that runs for several hundred meters underground. Thus, population estimates are for all of Cement Plant Creek, or at least the sections that would have an impact on the Rapid Creek fishery. Also, it is important to note that this is the first year this section of Cement Plant Creek has been sampled and therefore no trend data was available.

Species composition within Cement Plant Creek is similar to that of Rapid Creek except for the absence of rainbow and brook trout. However, this is not unexpected as Cement Plant Creek is located much lower in the watershed resulting in water temperatures not preferred by these species. Northern pike and creek chub were the only other two species sampled in Rapid Creek not found in Cement Plant Creek (Table 1).

The estimated number of juvenile brown trout (107) was a surprising discovery. Juvenile brown trout were by far the most abundant species followed by white sucker with an estimate of 26.

The abundance of juvenile brown trout and lack of adult brown trout would indicate Cement Plant Creek is important rearing habitat for brown trout and is an important

source of brown trout for Rapid Creek. Assessment of a length frequency histogram indicated a large proportion of sampled brown trout were probably age one fish. Based on this data, it appears that Cement Plant Creek is important habitat for age one fish. After age one, it appears most brown trout probably move out of Cement Plant Creek. This evidence indicated that while Cement Plant Creek probably has limited fishery potential in and of itself, but serves an important function to the Rapid Creek fishery. Due to its apparent significance to the coldwater fishery of Rapid Creek, I would recommend it be reclassified to at a minimum a coldwater marginal fishery and be managed as such.

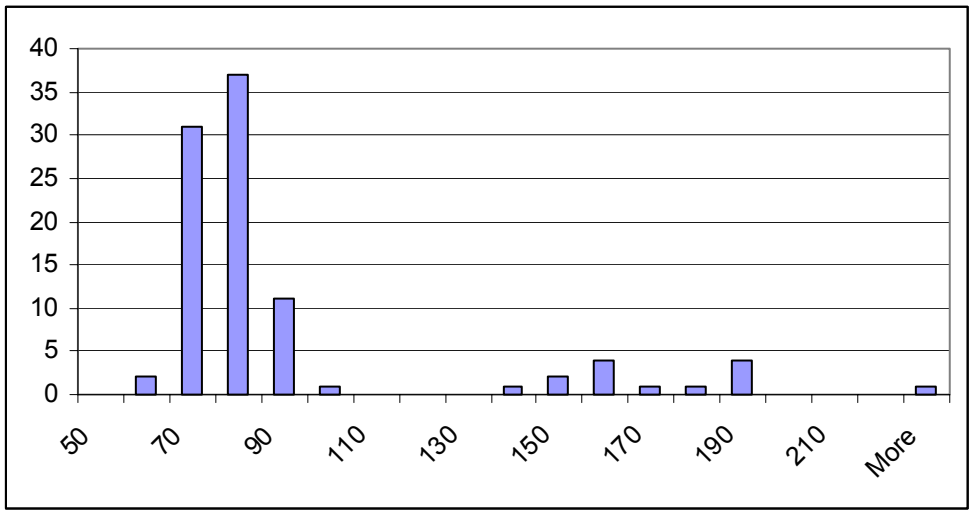

Figure 14. Length frequency histogram of brown trout sampled in Cement Plant Creek in the Rapid Creek Watershed.

Recommendations:

1. Continue to monitor populations in the didymo affected sections annually until completion of the research project currently underway on Rapid Creek.

2. Investigate longitudinal temperature profile of Rapid Creek by collecting continuous data at various stations along Rapid Creek to further understand areas where trout survival is likely limited by high summer temperatures.

3. Monitor water discharge within Rapid Creek and its effect on salmonid populations especially regarding the prolonged drought.

4. Increase sampling efforts to a minimum of 30 sample reaches every other year, thereby decreasing variance by increasing sample size.

5. Investigate the need to increase sample site length to ensure all habitat variability is being captured in our population estimates.

SOUTH DAKOTA STATEWIDE FISHERIES SURVEY

Name: Spearfish Creek Watershed County: Lawrence

Spearfish Creek watershed and Cleopatra Creek, a tributary to Spearfish Creek (Figure 1), were surveyed during 2007 to monitor fish populations and assess impacts of prolonged drought on the fishery. Brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss*, and brook trout *Salvelinus fontinalis* were documented in Spearfish Creek. The majority of Spearfish Creek and its tributaries are managed under standard regulations with a daily limit of five trout (in any combination) with one allowed 14 inches or longer. A one-mile reach of Spearfish Creek from the Maurice Intake upstream to the Hydro #2 building is currently managed with catch and release regulations for rainbow trout. Other trout species may be harvested according to standard regulations. This reach of Spearfish Creek is unique in that it contains the only naturally reproducing rainbow trout population in the Black Hills capable of maintaining a Class I rainbow trout (> 25 fish $\geq$ 200 mm / surface acre) fishery.

Methods

Three 100 m reaches in Spearfish Creek and one 100 m reach in Cleopatra Creek (Figures 2 and 3) were surveyed during September under base flow conditions and prior to the fall spawning of brown and brook trout. Conclusions about the status of fish populations based on these samplings are tenuous at best due to the relatively small number of sample sites. As a result of the small sample size, discussion of the status of fish populations will pertain only to the individual sites.

Despite the lack of statistical rigor, efforts were made to ensure the required assumptions 1) the population is static and 2) number of fish was recorded properly were met (Guy and Brown 2007). Block nets at the upstream and downstream boundaries were used to prevent fish from emigrating or immigrating within the sample site. Three passes were made with one or two backpack electrofishing units. Captured fish were anesthetized with carbon dioxide, measured to the nearest millimeter, weighed to the nearest gram and returned to the stream. After 50 individual lengths and weights were collected from small fish (< 100mm) of a specific species, bulk counts were then collected to expedite data collection. A three-pass depletion estimate was used to estimate the number of fish within the sample reach (Guy and Brown 2007). Estimated numbers of fish within reaches were averaged to yield an estimate of number of fish per 100 m throughout the creek.

In addition to fish data, pH, temperature, and specific conductance were measured and recorded. Additionally, stream widths were measured every 10 m and averaged to obtain an estimate of total area sampled.

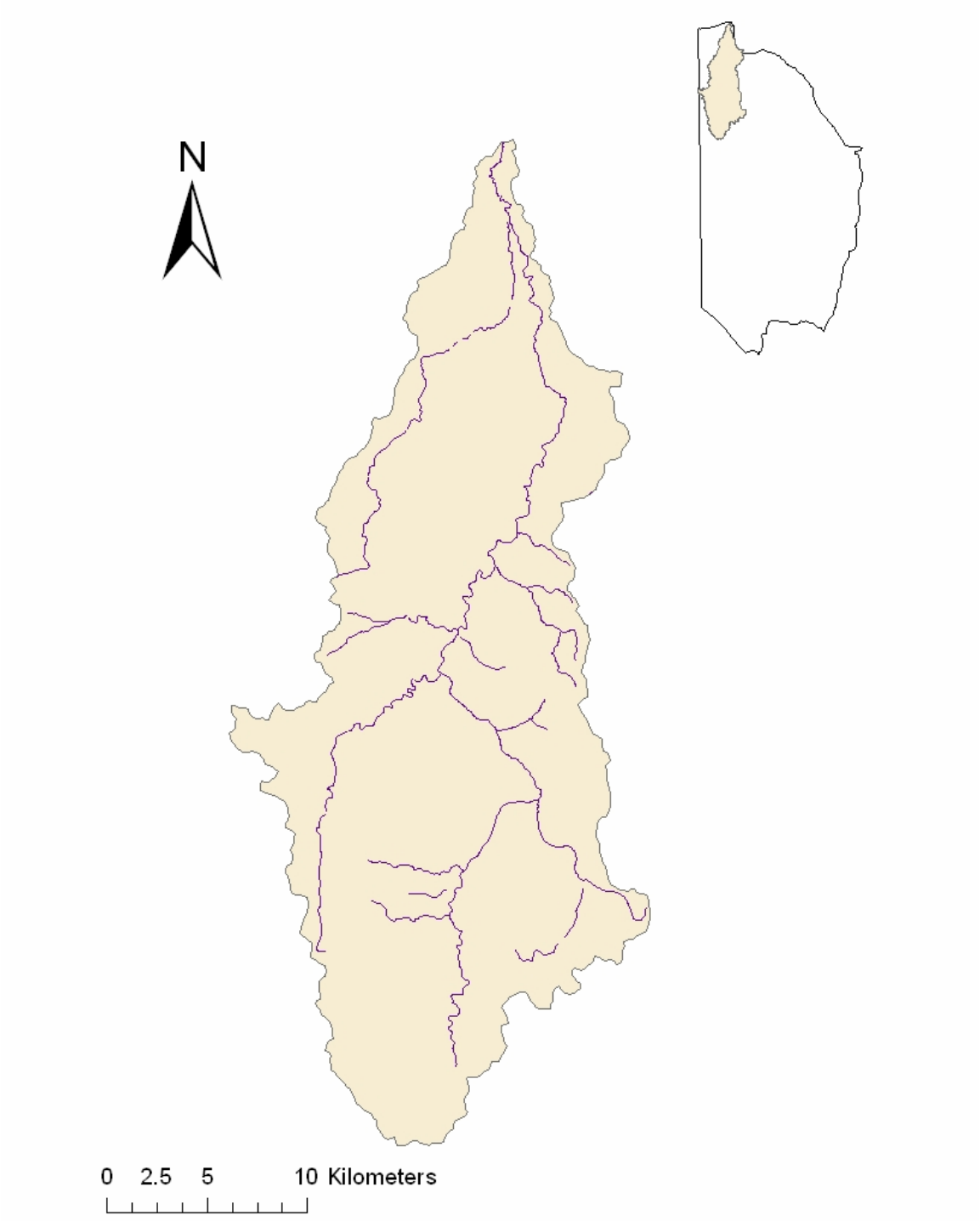

Figure 1. Map of Spearfish Creek Watershed and its location within the Black Hills Trout Management Area.

Figure 2. Sample site number 5 location (denoted by a star) in Spearfish Creek within the city of Spearfish.

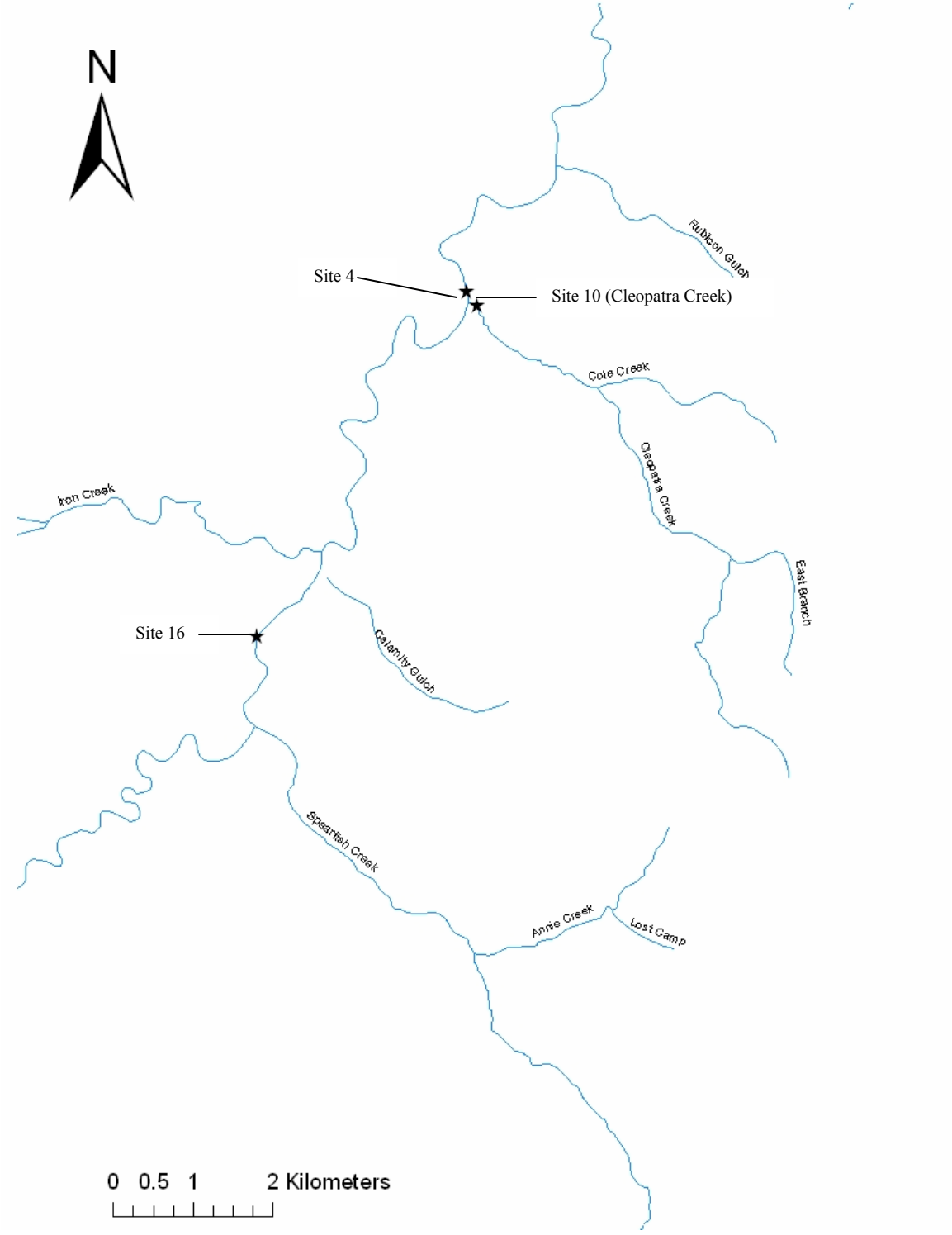

Figure 3. Locations of sample sites (denoted by starts) within Spearfish Creek and Cleopatra Creek above the city of Spearfish.

Results and Discussion

Spearfish Creek

Sampling in 2007 captured three species within Spearfish Creek. Species sampled included brown trout (*Salmo trutta)*, rainbow trout (*Oncorhynchus mykiss*), and brook trout (*Salvelinus fontinalis*). Brown trout were captured in all sample reaches, but rainbow and brook trout were only sampled in the reach below the confluence with Cleopatra Creek.

Site 16 is the most upstream of the sample sites (Figure 3). Sampling in 2007 resulted in only brown trout being captured. However, two juvenile rainbow trout and one juvenile brook trout (< 200 mm) were sampled in this reach in 2006. Therefore, a small number of rainbow brook trout may inhabit this section of stream but occur in densities too low to be detected in this sampling.

Site 16 had the highest number of adult brown trout per 100 m (75) and the second highest number per acre (363) of the three Spearfish Creek sample sites. With 363 brown trout per acre, this section of Spearfish Creek is classified a Class I brown trout fishery. Abundance of juvenile brown trout was highest in site 16 (288 per 100 m) indicating this section may contain spawning and/or nursery habitat important to brown trout.

Trends in brown trout abundance indicated an increase in numbers of both juvenile and adult trout in site 16 (Figure 4). While no sampling occurred between 1998 and 2004, the population appeared to be fairly static during this time period. However, between 2004 and 2005 there is a dramatic increase in the number of juvenile brown trout. The most likely explanation for this increase is the additional water contribution by Little Spearfish Creek. Beginning in late fall of 2003, Little Spearfish Creek began contributing 15-17 cfs of water to Spearfish Creek (Ron Koth, SDGF&P personal communication). This additional water likely improved and created spawning habitat resulting in increased spawning success by brown trout in this section of Spearfish Creek. The increased spawning success may explain the general trend of increased abundance of adult fish between 2005 and 2007.

Site 4 was located approximately 6 stream kilometers downstream of site 16 and is in the section of stream managed under catch-and-release regulations for rainbow trout (Figure 3). Site 4 was the only sample site where brook and rainbow trout were sampled in addition to brown trout. Occurrence of rainbow and brook trout in this sample reach is probably due to the close proximity to Cleopatra Creek. A recent radio telemetry study indicated that Cleopatra Creek may be an important spawning and nursery tributary for rainbow trout (South Dakota Game, Fish, and Parks unpublished data). Sampling in 2007 within Cleopatra Creek indicated relatively high abundances of juvenile rainbow and brook trout in this stream (South Dakota Game, Fish, and Parks, this report). Therefore, the presence of juvenile rainbow and brook trout in this reach of Spearfish Creek is probably the result of escapement from Cleopatra Creek. Brook trout however, occurred

in low abundances with only four juveniles and no adults sampled. Therefore, no more discussion will be given to brook trout within Spearfish Creek.

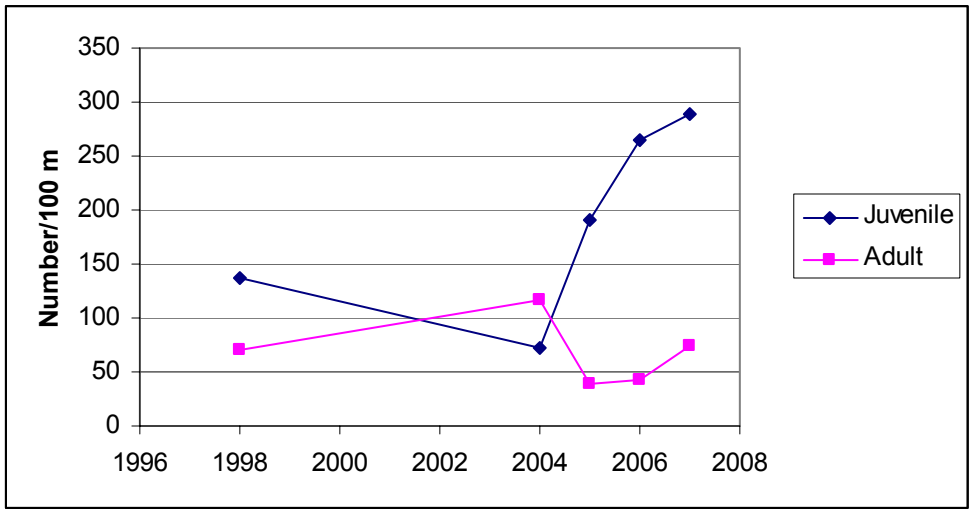

Figure 4. Trends in abundance of juvenile and adult brown trout for site 16 within Spearfish Creek.

Site 4 had the lowest number of adult brown trout per 100m (35) and number of adult brown trout per acre (155). This is likely a result of interspecies competition with rainbow trout that are present within this reach. There were 20 adult rainbow trout per 100 m and 89 per acre. If brown and rainbow trout are considered together, densities of trout in this reach more closely resembles that of densities of brown trout in the other two reaches sampled in Spearfish Creek. This section of Spearfish Creek is unique in that it is classified as a Class I rainbow trout fishery and a Class I brown trout fishery. No other reaches in any stream sampled in 2007 within the Black Hills have this distinction.

Trends in adult brown trout abundance indicated a decline in numbers from 2001 to 2004 with numbers leveling off between 2004 and 2007 (Figure 5). Numbers of juvenile brown trout display more annual variability but exhibit an overall decline beginning in 2000. A major contributing factor to this decline is likely the prolonged drought in the Black Hills and the associated reduction in stream flow. Aside from a few large precipitation events, stream flow remains relatively constant throughout the year in Spearfish Creek. Examination of mean annual flow illustrates the effects drought has had on discharge within Spearfish Creek (Figure 6). This decreased flow has likely resulted in a reduction in the amount of suitable habitat reducing available resources for trout (i.e., resting habitat, cover, and available forage) thus reducing carrying capacity.

Adult rainbow trout exhibited a decline in abundance similar to that of brown trout (Figure 7). However, rainbow trout abundance has not leveled off and actually increased between 2006 and 2007. Declines in rainbow trout are likely do to the same reason discussed above for brown trout.

Juvenile rainbow trout experienced a 14 fold increase from 2002 to 2006 (Figure 7). This increase may be a result of juvenile rainbow trout emigrating from Cleopatra Creek. Do to the prolonged drought, water levels in Cleopatra Creek may no longer be sufficient to create required nursery habitat thus forcing the juvenile rainbow trout to move downstream into Spearfish Creek. Between 2006 and 2007 numbers of juvenile rainbow trout dropped considerably. The most likely explanation for this decline is occurrence of a near 100 year runoff event in early June of 2007. High flows during this time probably resulted in a large number of juvenile trout being washed downstream. However, this flow event may have a positive impact in the long term by breaking up the calcium carbonate the armors the substrate of Spearfish Creek. With more substrate available for spawning, there may be an increase in numbers of juvenile rainbow trout in the next year.

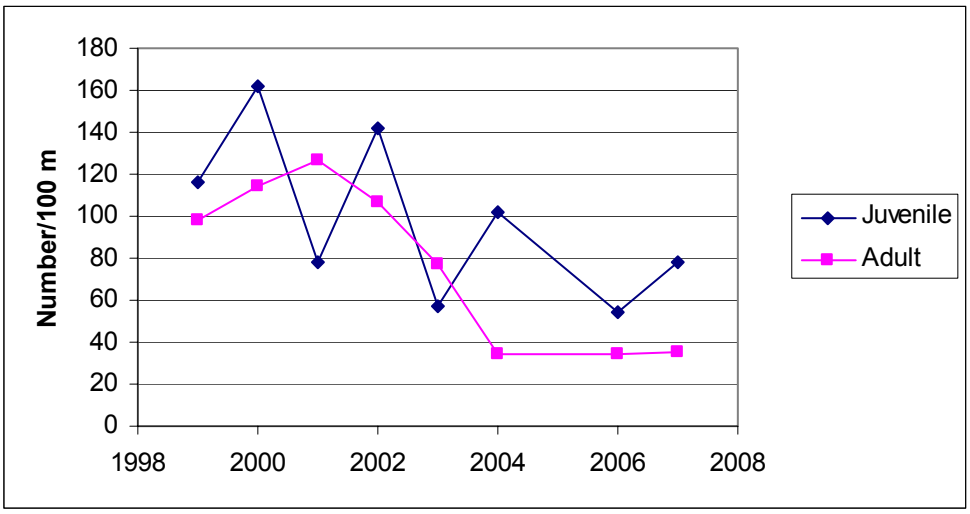

Figure 5. Trends in number of juvenile and adult brown trout per 100 m within site 4 in Spearfish Creek.

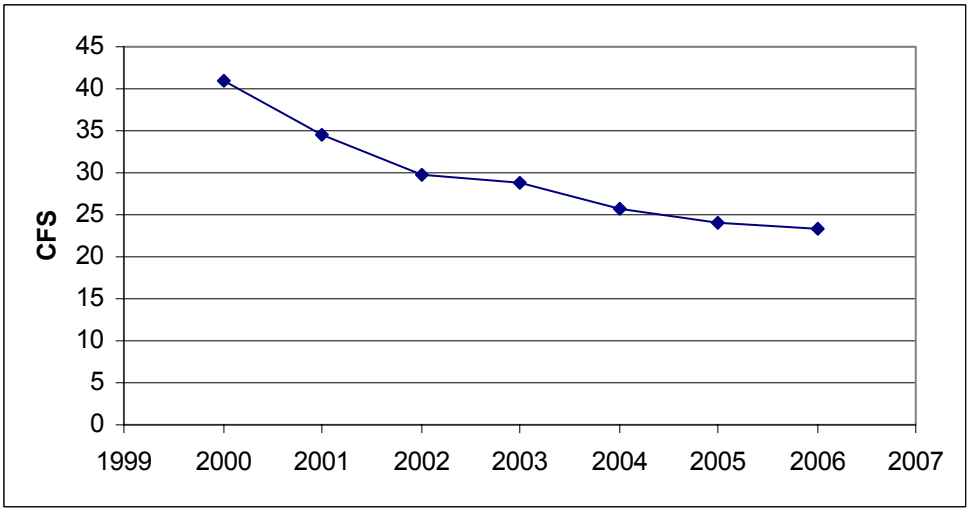

Figure 6. Mean annual discharge for Spearfish Creek constructed from flow data collected at USGS gauging station in Spearfish Creek.

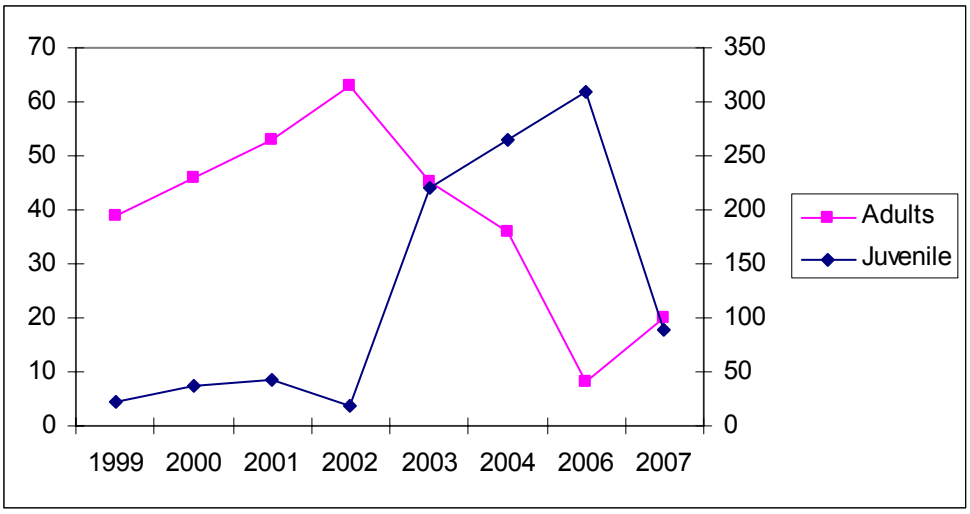

Figure 7. Trends in number of juvenile and adult rainbow trout per 100 m within site 4 in Spearfish Creek.

Site 5 is the most downstream sample reach and is located within the town of Spearfish (Figure 2). Brown trout was the only species captured in this site with the last rainbow trout sampled in this reach being a single juvenile in 1987.

This reach of Spearfish Creek had the second highest number of adult brown trout per 100 m (66) and the highest number per acre (390) resulting in this section also being classified as a class I brown trout fishery. This section had the lowest number of juvenile brown trout per 100 m (59). Site 5 was the only reach where adults occurred in a higher abundance than juveniles. Reasons for this are unknown but may be a factor of the habitat that is available in this reach.

Trends in abundances of adult and juvenile brown trout are similar to that of brown and rainbow trout in site 4 (Figure 8). However, numbers are higher in this section of stream probably the result of the absence of rainbow trout. The same factors are probably at work in this section of stream as well resulting in declines of adult brown trout. One difference is the apparent increase in juvenile brown trout between 2004 and 2006. The reason for this increase is not clear, but the subsequent decline between 2006 and 2007 may be the result of the high flow event in June of 2007.

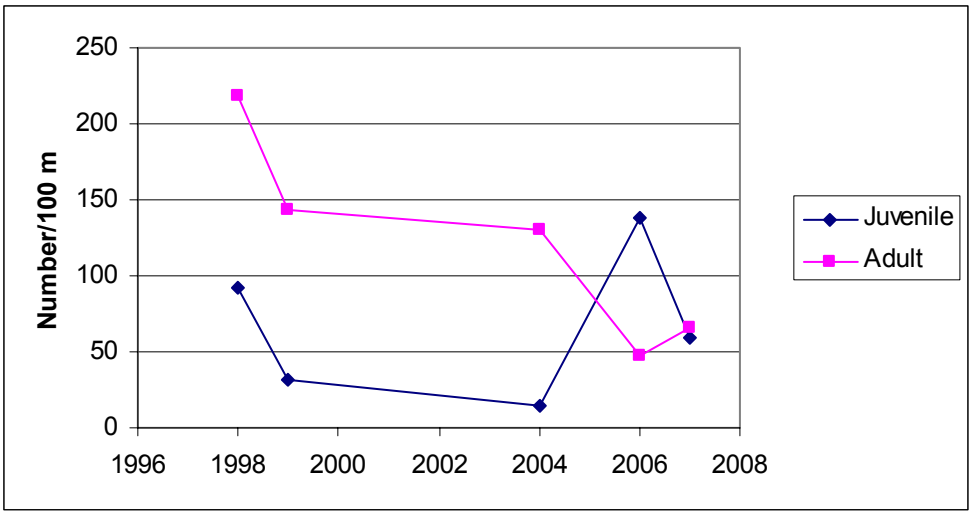

Figure 8. Trends in number of juvenile and adult brown trout per 100 m within site 5 in Spearfish Creek.

Cleopatra Creek

Cleopatra Creek is a small tributary that enters Spearfish Creek about 15 m above site number 4 (Figure 3). The lower boundary of the sample site on Cleopatra Creek is about 15 m upstream of the confluence with Spearfish Creek. This site on Cleopatra Creek has not been sampled since 1997 rendering it impossible to examine trend data.

Brook trout, brown trout, and rainbow trout were sampled in this reach of Cleopatra Creek. However, the samples were dominated by juvenile fish (< 200 mm) with few adults being sampled (Table 1). The disparity in the numbers of adult and juvenile fish may indicate that Cleopatra Creek may serve as important spawning and nursery habitat, especially for brook and rainbow trout. Results of this sampling appear to corroborate results of a radio telemetry study conducted by South Dakota Game, Fish, and Parks that indicated rainbow trout migrated relatively long distances in Spearfish Creek to spawn in Cleopatra Creek (James 2007).

The importance of Cleopatra Creek to the Spearfish Creek fishery is not completely understood, but it does appear the habitat within the creek is important to early life stages of brook and rainbow trout. Drought may be affecting the habitat within Cleopatra Creek which may be negatively impacting populations within Spearfish Creek. Further investigation is necessary to determine Cleopatra Creek's importance especially for brown trout. Data is lacking on spawning activity of brown trout within the Spearfish Creek Watershed.

Table 1. Population estimates in number of fish per 100 m of stream and number of fish per surface acre of water for Cleopatra Creek in the Spearfish Creek watershed.

Species	Size	Number/100 m	Number/ac
Brook trout	< 200 mm	267	3,034
Brook trout	≥ 200 mm	3	34
Brown trout	< 200 mm	4	45
Brown trout	≥ 200 mm	0	0
Rainbow trout	< 200 mm	124	1,409
Rainbow trout	≥ 200 mm	1	11

Recommendations:

1. Continue to monitor populations within the Spearfish Creek on a bi-annual basis.

2. Increase sampling efforts to a minimum of 30 sample reaches every other year, thereby decreasing variance by increasing sample size.

3. Monitor relative abundance of salmonids in the smaller tributaries every 3-5 years.

4. Investigate spawning activities of brown and rainbow trout to better understand timing of spawning movement and the possible utility of tributaries as spawning habitat.

5. Investigate the need to increase sample site length to sample sites are representative of Spearfish Creek and habitat variability is being captured.